Graphing and Uncertainty

What is physics?
The study of matter and interactions (forces cause changes in energy)
Physics theories are tested through experiment and observations.
Observations are quantified through measurement.
All measurement has an element of uncertainty.

- set by the use of the instrument - half of the smallest division, possibly or the last digit of a digital device.
  eg. the smallest division on the clock is the second, so we can measure the time to 10:25.56 this value implies and uncertainty of about +/- 0.5 s at least, probably +/- 1 second.
  Stopwatches have an uncertainty of hundredth of a second but your reaction time is about 0.2s, so when you do the lab next class, round your time to the tenth of a second.
- uncertainty is also limited by the Heisenberg uncertainty principle - you can't know the position and momentum of a particle to infinite precision.

2 ways of indicating uncertainty
explicitly by including +/- with every measurement
or implicitly by the number of significant digits

2.0 s and 2.00s and 2s are the same time but different precisions.

sig fig rules:
all non-zero digits are significant
Things that give the decimal place are not significant
$x10^6$ has no sig figs
0.0000002 has 1 sig fig
20000000 has unclear sig figs, to be safe you can assume 1 sig fig
zeros between sig figs are significant
zeros after a decimal and after a sig fig are significant.
how many sig figs?
a) 2.0030 cm b) 0.003030 kg c) 2.030×10^7s
b) 5 b) 4 c) 4

multiplying and dividing:
round the answer to the least number of significant figures in the products

eg. 2.987984375789 x 1.0 = 3.0
1 sf's 2 2 sf's

Adding and subtracting:
round the answer to least precise decimal place after everything is in the same unit and power.

eg. 200.5 km + 1 240 m + 1.2 x 10^3 m

200.5km
\+ 1.24 km
\+ 1.2 km
= 202.9 km

0.4999999999999repeating round down
0.5000000000000000000000001 round up
exactly 0.5 - number before is even - round down
number before is odd - round up

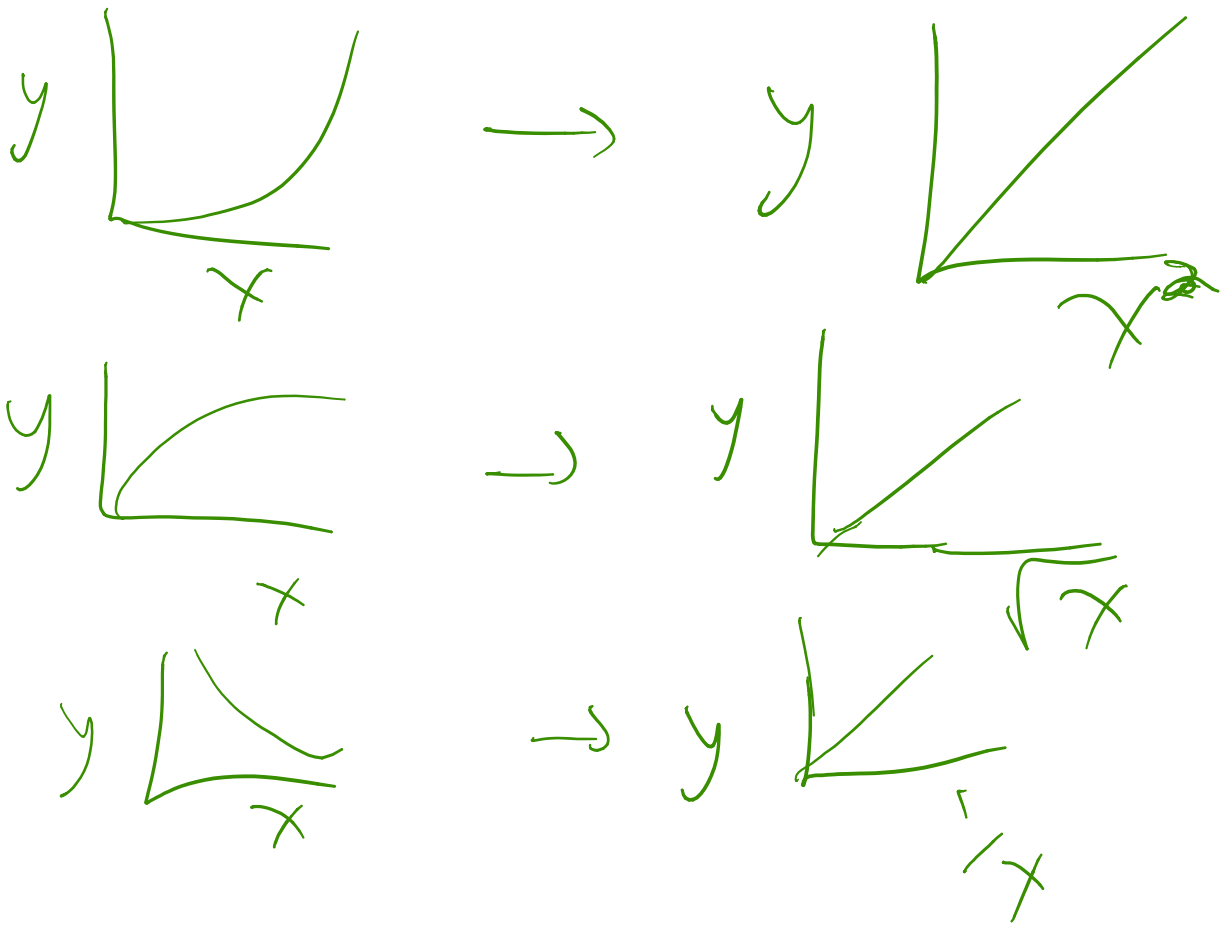
Graphing:
purpose: get an equation and look at uncertainties and irregularities

include on a graph:
title - say something about the lab
axes - labeled with units and an even scale
choose the scale so the data takes up at least half the graph.
points - use a cross to indicate uncertainty
best-fit line - needs to be close to all the data but should be smooth (don't connect the dots)
if the line is linear, then find the equation:
y=mx + b m is slope (rise/run with units and sig figs - usually 2 or 3 sig figs is fine)

b is y-intercept - calculate if x doesn't start at 0

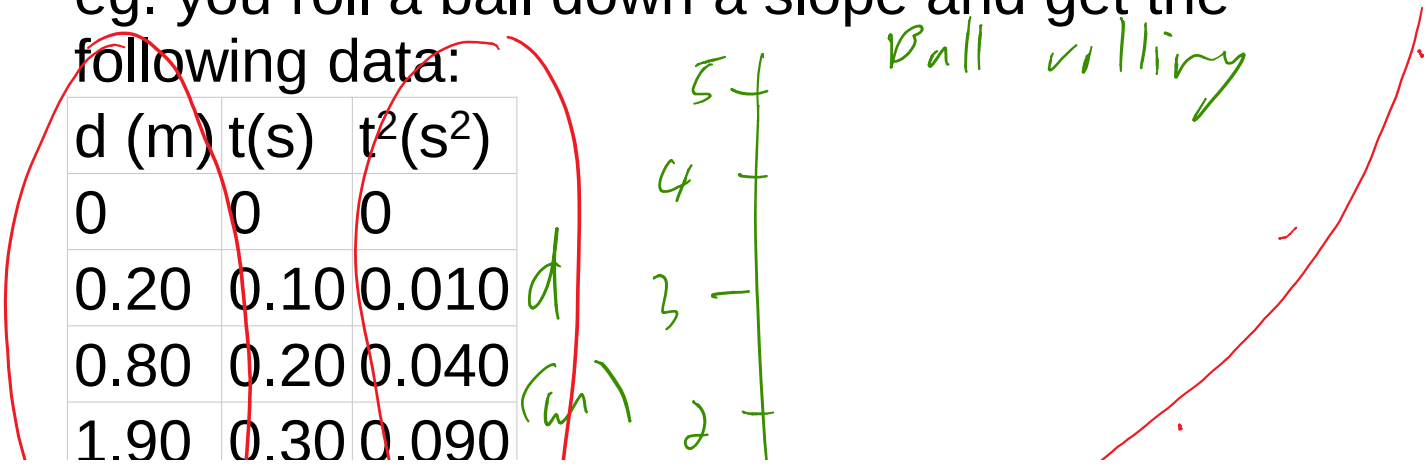
replace y and x with variables
eg. d= 2.0 m/s t + 0.50 m

if the line is not linear: make it linear

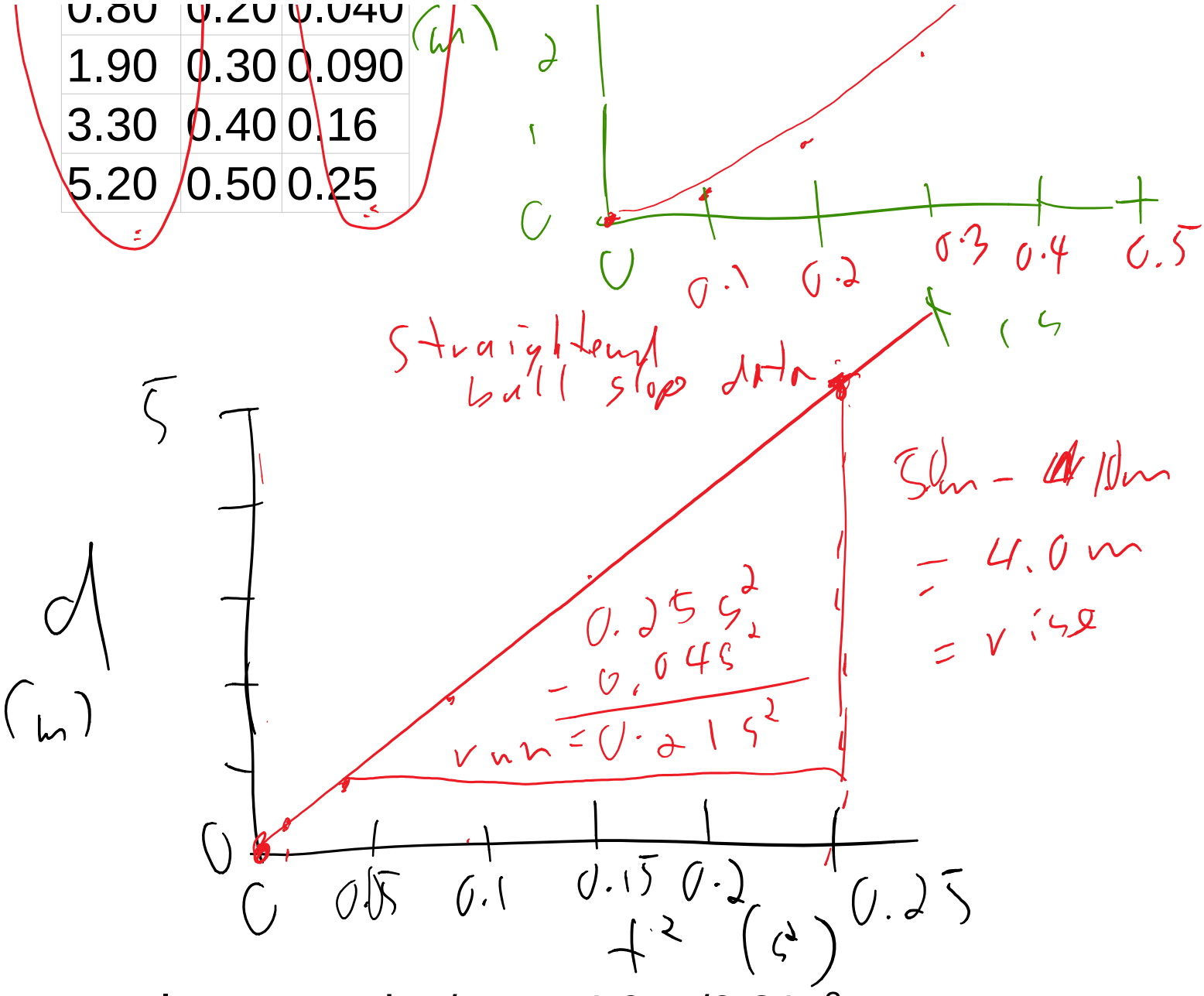


eg. you roll a ball down a slope and get the following data:

d (m)	t(s)	$t^2(s^2)$
0	0	0
0.20	0.10	0.010
0.80	0.20	0.040
1.90	0.30	0.090



0.80	0.20	0.040
1.90	0.30	0.090
3.30	0.40	0.16
5.20	0.50	0.25



slope, m = rise/run = 4.0 m/0.21s² =
4/0.21=19.0476
m = 19 m/s²

y intercept = 0.1m

y=mx + b
d = 19 m/s² t² + 0.1 m

Assignment
p38 of the worksheet
Q12-15 sig fig problems
Q16, 17, 19 graphing problems
graph q 17 and get an equation
graph q 19, straighten the graph and get the equation
problem solving: q 22, 29